NOTES AND EXTRACTS.

METEOROLOGY IN HAWAII.

The Pacific Commercial Advertiser, Honolulu, Hawaii, January 1, 1902, contains several interesting articles descriptive of the agricultural and commercial industries of the Territory of Hawaii. Naturally, in connection with these industries, the climate receives attention, and on this subject a special article was contributed by Mr. Curtis J. Lyons,[1] Territorial Meteorologist, already known to the readers of the MONTHLY WEATHER REVIEW through his monthly climatological reports.

We quote the following from Mr. Lyon's article, including, however, numerous corrections and additions which he has kindly made in the original text:

[1] In connection with this article the following note was published:

Curtis J. Lyons was born at Waimea, Hawaii, in 1833, his parents being members of the missionary band that arrived the year previous in the whaleship *Averick* from New Bedford. His father, the Rev. Lorenzo Lyons, was a man of very considerable attainments and has been considered preeminently the lyric poet of Hawaii.

In 1850, after a three years attendance at Punahou College, he joined the land commission for locating Kuleana and land grants, remaining with them for three years during which time he acquired an extensive knowledge and acquaintance with the early land system, which has been of the greatest value to the department and governments ever since. The money he had earned enabled him to enter Williams College in Massachusetts, from which he was graduated in 1858. He then applied himself to the study of theology, but at the end of two years his health failed, compelling his return to the islands, where he recovered in due time. He then entered the newspaper field, working on both the Kuokoa and Advertiser as translator and editorial writer. He was also a member of the legislature during two sessions. He joined the government survey service in 1871 and is still connected with that department. Since 1896 he has been Territorial Meteorologist.

The local government meteorological work began in 1881 in a very small way, as a voluntary service in connection with the government survey, superadded to the surveying duties of the office. First the barometer and later the temperature, wind, and cloud observations were made. Instruments were standardized by comparison with those of scientific government parties visiting Honolulu. In 1883 rainfall records were undertaken, and the present station at 1508 Alexander street, Punahou (see fig. 2, No. 1), was occupied. In 1890, by direction of the then Minister of Interior, Lorin A. Thurston, the systematic collection of rainfall data was begun, many of the observers taking up the matter in response to letters from the minister himself. There are now about eighty stations reporting rainfall. At the same time the weekly publication of a summary, which appears on the last page of the Advertiser and also in the Gazette, was instituted and continues to this day.

At about the same time the study of the humidity of the atmosphere was taken up. Previous to this few really accurate humidity observations had been made anywhere, even in Europe and America, owing to crudities in practise; and even now the moisture is apt to be overestimated.

In the early nineties the United States Weather Bureau and the Hydrographic Office both requested to have detailed records sent them, which has been done regularly.

For three years past the leading papers have been furnished by telephone with the daily weather items, including the dew-point and humidity. The effort to furnish forecasts for short periods was taken up at the request of the papers themselves, and has proved in a measure successful. Of course, there is no background to the west to draw information from by telegraph, as on the mainland. Should a cable be laid to Midway Island, it would be of service in the winter time, as the winter storms and changes come from that direction.

The annual reports for six years, viz, 1892–1897, inclusive, were published. Copies of all but 1892 can still be had. The reports for 1898 to 1901 are soon to be published and will be accompanied by a pamphlet containing the monthly rainfall for every station occupied previous to 1897 for the entire period of observation up to the end of 1900.

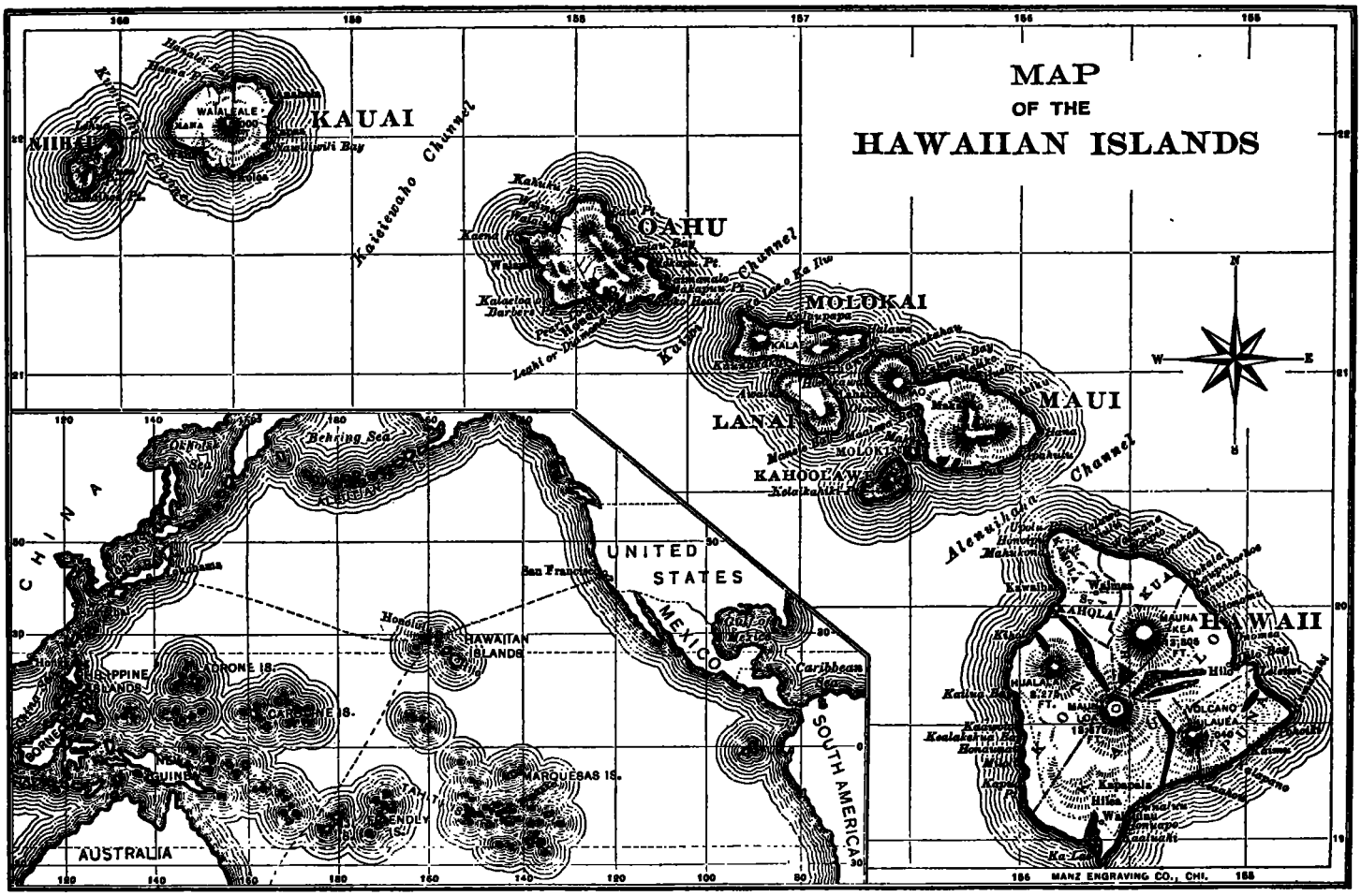

FIG. 1.—(Reproduced from Bulletin No. 95, Office of Experiment Stations.)

CLIMATOLOGY OF HAWAII.

As to the results: The mean annual temperature of Honolulu, Oahu, at sea level is 74° F., and the annual departures from this mean are not over a degree. The mean of 6 a. m., 2 p. m., and 9 p. m. temperatures is taken as the standard average, the mean of the maximum and minimum being about 0.7° too high. It is commonly supposed that the temperature on the windward side of the islands is much less than on the leeward side, but it is doubtful whether any place at sea level is over a degree cooler than Honolulu. While the temperature in the West Indian Islands has no doubt been over estimated, yet the mean is probably not less than 78°, being 4° higher than here, which is quite a difference for the Tropics.

The temperature diminishes with elevation by ratios that vary with the locality; sometimes it is as rapid as 1° F. in 200 feet, and again it is only 1° in 400 feet. Probably 1° in 300 feet is a fair average.

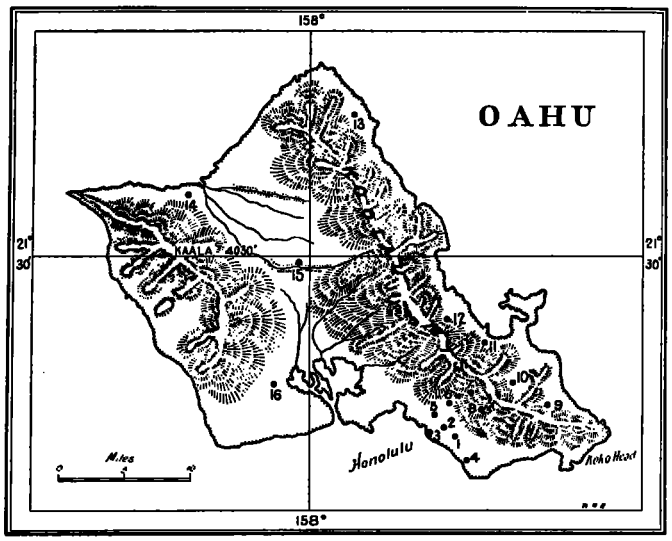

FIG. 2.

No.	Station.	Elevation, feet.	No.	Station.	Elevation, feet.
1.	Punahou (Weather Bureau)	47	9.	Waimanalo	25
2.	Kulaokahua (W. R. Castle)	50	10.	Maunawili	300
3.	United States Naval Station	6	11.	Kaneohe	100
4.	Kapiolani Park	10	12.	Ahuimanu	350
5.	Nuuanu (Hall)	50	13.	Kahuku	25
6.	Nuuanu (Electric Station)	405	14.	Waialua	20
7.	Nuuanu (Luakaha)	850	15.	Wahiawa	900
8.	Manoa	300	16.	Ewa Mill	60

The daily range of temperature at Honolulu averages 11°; at greater elevations it averages from 15° to 16°, while at Pepeekeo, Hilo, (see fig. 3, No. 3) on the windward coast of Hawaii it is only 7°. The monthly mean temperature at Honolulu ranges from 70° in January to 78° in July and August. The extreme temperatures are generally 54° and 88°. In rare instances 50° and 90° have been recorded.

Variations in the humidity have more effect upon what is termed the sensible temperature than does the temperature itself. The thermometer at 80°, with the dew-point at 62° to 64°, gives a very comfortable atmosphere; at 75°, with the dew point at 70° to 72°, it is decidedly oppressive. Rapid evaporation in the first instance cools the skin and frees the lungs; in the other case the lack of it blocks the pores and the cells. A sudden fall in the dew-point is only bracing to the strong, since it causes sensitive people to take cold. The average dew-point at Honolulu is 64°; the average absolute humidity, 6.6 grains of moisture per cubic foot; and the relative humidity or percentage of saturation, 72 per cent, which is no higher than that of maritime cities on the mainland.

The trade winds blow here on an average 260 days in the year. A good deal of what is called south wind is merely sea breeze. There is sometimes a land breeze at Honolulu; it is very light and comes from the Ewa Mountains. The disturbances in the winter time are mostly caused by the southern edges of the great circular or revolving storms that cross the Pacific Ocean from Japan to the American coast, passing well to the northward of Hawaii. Some such storms come up from the southwest, and are probably the genuine "Konas," which are rare. November and February have the heaviest rain records. December and January are sometimes very delightful months and sometimes quite the contrary. The character of the winter depends on the belt of latitude on which the storms move.

Much interest attaches to the rainfall of the islands because of the marked variations in the amount with the locality. We will accept the fundamental principle in rain science that when moist air ascends from sea level to a high altitude it cools and has to part with some of its water, i. e., it rains. In Oahu (see fig. 2, Nos. 1, 2, 3, 4) the winds strike the Koolau Mountains, Konahuanut, etc., and shoot upward and onward, giving 120 inches of rainfall a year at Luakaha, in Nuuanu Valley (see fig. 2, No. 7). On the other hand, the wind comes around Koko Head and over Waialae and Kapiolani Park (see fig. 2, No. 4) without being deflected upward, and the rainfall there is hardly 20 inches a year.

For the same reason the huge mountains, Mauna Kea and Mauna Loa, Hawaii, cause the heavy rains of Hilo and Olaa (see fig. 3, Nos. 2 and 26), averaging at different points from 100 to 200 inches annually. Nahiku, Maui (see fig. 4, No. 6), 1,600 feet elevation has the record for authenticated monthly rainfall, viz., 102.46 inches; Wahiawa Mountain, on the south side of Kauai (see fig. 5, No. 6), has the annual record, viz., 250.58 inches for 1901. Laupahoehoe, Hilo (see fig. 3, No. 6), has the greatest short period record, 41.30 inches in twenty-eight hours. Some places on the lee coast of Hawaii probably do not have over 8 inches of rainfall per year. The Kona forest belt, on the west side of the island of Hawaii, has its rainy season in July and August. This is exceptional and is caused by the combination of the sea breeze and back current of the trades, which carries the sea air up the western mountain slope.

The balmy character of Hawaiian atmosphere is largely due to the fact that the supply comes from a high elevation. That is, the air is carried to the equator by the trade winds there rises, parts with its moisture in the heavy rains of that belt, returns overhead as the southwest upper current, descends to sea level at about latitude 30°, and comes down to us as the fresh northeast trade.

Hawaiian meteorology is therefore not the monotonous subject that it appears at first glance.

Table 1 illustrates very clearly the temperature conditions in Honolulu. The diversified surface of the country often causes slight differences of temperature even in places having the same elevation and the same average temperature. This is particularly true on cool mornings when the temperature opposite the mouth of a valley often is two or three degrees lower than that opposite the foot of a ridge. Again, a heated hillside to windward of a station will make it warmer than others at midday, although it may be the cooler in the early morning.

THE SUGAR INDUSTRY.

The relation of climate to the sugar industry of the islands is illustrated by the following extracts:

THE SOUTH KONA AGRICULTURAL COMPANY.

The location of this company is in South Kona, island of Hawaii. (See No. 29, fig. 3.)[1]

Cane in small patches has been grown on these lands from time immemorial. For the past three years it has been grown in acre quantities, and 350 acres are now under cultivation on this plantation. The growth shown is absolutely phenomenal. Without steam plowing, fertilizing or irrigation, and with but little attention, the growth, weight, and analysis of the cane shows a yield of 6 tons of sugar and upward per acre.

The rainfall of South Kona is ample for all vegetation, no irrigation being required for any purpose, even taro, essentially a water plant, grows luxuriantly. The rainfall is also distributed with great evenness throughout the year, as will be seen by the following records of rainfall on the plantation lands:

One of the peculiar advantages of this district for purposes of cane culture is the fact that there is practically no wind. It is so sheltered by high mountains that the trade winds never reach it, and the gentle land breeze at night and sea breeze in the daytime are the only winds, except during brief periods in the winter months. This has an important bearing on the growth of cane, as wind more than sun dries up moisture, and high winds break down, destroy, and stunt much cane in windy districts.

TABLE 2.—*Rainfall at Kalahiki, South Kona agricultural plantation (29, fig. 3.)*

	1895.	1896.	1897.		1898.		1899.		1900.	1901.	
	750 feet.	750 feet.	750 feet.	1,200 feet.	750 feet.	1,200 feet.	750 feet.	1,200 feet.	750 feet.	750 feet.	1,800 feet.
January	.....	.....	0.61	1.18	1.34	1.49	1.71	2.22	1.80	1.50	2.15
February	.....	0.89	3.04	2.68	1.27	2.63	2.72	3.28	1.89	10.50	13.20
March	.....	2.87	1.07	3.38	3.68	4.77	4.18	6.77	2.93	5.74	10.30
April	.....	1.86	2.45	1.78	6.80	9.18	4.22	7.29	2.20	5.47	12.15
May	0.84	6.67	2.20	2.61	2.17	3.41	7.16	10.12	1.80	10.90	27.80
June	3.98	2.81	5.53	4.85	4.74	8.27	4.55	5.60	2.51	3.66	8.61
July	4.66	2.95	5.52	7.15	2.59	5.25	6.07	4.58	4.17	4.15	10.63
August	4.72	2.37	2.63	8.26	3.33	4.78	5.01	8.78	5.31	5.28	5.84
September	5.14	2.01	6.93	4.06	2.29	7.34	3.63	5.40	3.60	3.29	6.83
October	2.83	4.82	3.50	9.11	1.69	4.06	2.51	2.21	4.98	2.49	5.05
November	9.10	0.79	1.62	5.02	4.48	8.18	2.15	5.10	3.17	3.13	5.29
December	5.95	3.79	2.20	3.07	1.88	5.92	0.50	1.05	1.79	.....	.....
Total	37.22*	31.83	37.26	55.15	36.32	65.28	44.41	62.30	37.15	56.13*	107.85*

*Unfortunately the records for a few months have been lost (before South Kona Agricultural Company owned the place), and in 1900 the 1,200-feet altitude gage broke and was not replaced; the 1,800-foot gage has been selected as averaging better with the 750-foot gage. Returns for December, 1901, could not be had before going to press.

[1] The station is apparently about 10 miles south-southeast of the location given in fig. 3.—ED.

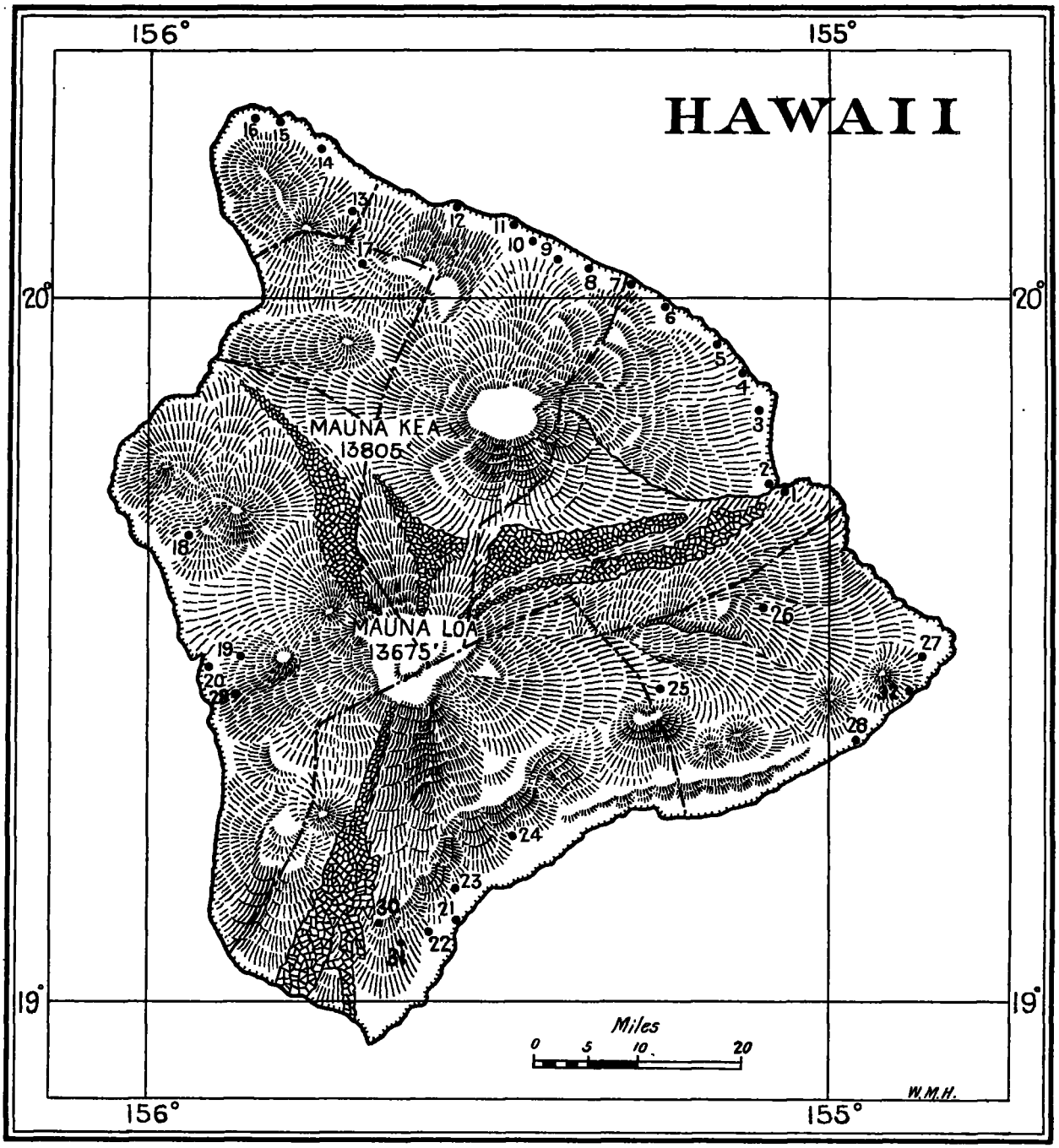

FIG 3.—HAWAII.

No.	Station.	Elevation, feet.
	HILO, e. and ne.	
1.	Waiakea	50
2.	Hilo (town)	100
3.	Pepeekeo	100
4.	Hakalau	200
5.	Honohina	300
6.	Laupahoehoe	500
7.	Ookala	400
	HAMAKUA, ne.	
8.	Kukaiau	250
9.	Paauilo	750
10.	Paauhau	300, 1,150
11.	Honokaa	425, 1,900
12.	Kukuihaele	700
	KOHALA, n.	
13.	Awini Ranch	1,100
14.	Niulii	200
15.	Kohala	235, 521
16.	Hawi	300, 600
17.	Waimea, e	2,720
	KONA, w.	
18.	Kailua	950
19.	Kealakekua	1,580
20.	Napoopoo	25
29.	Kalahiki	750, 1,200, 1,900
	KAU, sc.	
21.	Honuapo	15
22.	Naalehu	650
23.	Hilea	310
24.	Pahala	850
30.	Kahuku Ranch	1,680
31.	Waiohunu	1,000
	PUNA, e.	
25.	Volcano House	4,000
26.	Olaa	1,700
27.	Kapoho	110
28.	Kalapana, se	8
32.	Poholki	.....

THE PUNA SUGAR PLANTATION.

The district of Puna on the island of Hawaii (see fig. 1) is the most tropical and the least known of any section of the islands. The fact of its intensely tropical character prevented its becoming known, for, with the exception of a narrow rocky strip at the sea shore, the greater part of the district is covered by a dense and luxuriant growth of trees, ferns, and creepers, which are impenetrable except with the aid of a gang of men wielding axes and cane knives. Thousands of acres of tree ferns from 10 to 40 feet high, with trunks from 2 to 4 feet in diameter are still standing in Puna. There are more cocoanut and bread fruit trees in Puna than in all the remainder of the territory put together. Thousands of bushels of the finest guavas that grow go to rot in the district every year, while wild bamboo, awa root, yams, and mangos are common.

Because the narrow strip at the beach and some ancient lava flows, that were in sight, were rocky, it was taken for granted that the whole district was rocky, and until ten years ago it was in the undisturbed possession of a few ranchmen and natives who lived in primitive simplicity.

The climate is of more importance to a sugar cane plantation than soil, for if there are droughts, artificial irrigation must be practised, immensely increasing the expense. If there are even occasional "dry spells," or interruptions for only a month or so in the rainfall, it stunts the cane and greatly reduces the yield of sugar.

A drought is absolutely unknown in Puna. It rains on the Puna plantation, without fail, every month in every year, sufficiently to keep up a strong and steady growth of sugar cane. The official record of rainfall for this portion of the district has been kept since 1892, and is shown in Table 3.

TABLE 1.—*Record of temperature for 1901 in Honolulu, territory of Hawaii, kept by W. R. Castle,* altitude 50 feet.*

Day of month.	January.			February.			March.			April.			May.			June.			July.			August.			September.			October.			November.			December.		
	6 a. m.	1 p. m.	9 p. m.	6 a. m.	1 p. m.	9 p. m.	6 a. m.	1 p. m.	9 p. m.	6 a. m.	1 p. m.	9 p. m.	6 a. m.	1 p. m.	9 p. m.	6 a. m.	1 p. m.	9 p. m.	6 a. m.	1 p. m.	9 p. m.	6 a. m.	1 p. m.	9 p. m.	6 a. m.	1 p. m.	9 p. m.	6 a. m.	1 p. m.	9 p. m.	6 a. m.	1 p. m.	9 p. m.	6 a. m.	1 p. m.	9 p. m.
1	66	77	67	63.5	78	61	68	79	74.5	72	82	73	70	80	72	74	84	72	74.5	86	76.5	73	86	75	75	85	74	73	80	73	72	84	71	64	80	73
2	61	74.5	64.5	58	75	68	73.5	71.5	68	70	80	71	71	80	72	73	84	75	76	85	76	73.5	85	76	76	85	78	72	77	73	69	85	73	69.5	80.	70
3	62	73	67	67	76	68	68	74	68	69	81	71	71	81	73	75	85.5	75	75.5	86	77	73	84	76	74	84	77	70	80	75	71	81	71	70	79.	5 73.5
4	66	77	68	69	74	72	68	74	69	67	80	72	73	82	74	73.5	84	70	75	86	76	69	84	75.5	76	86	76	70	79	73	71	82	75	73	78	74
5	65	77	68	68	72	72	69	76	71	70	78	72	75	80	73	67	87	65	75	85	73	75	85	77	73.5	87.5	75	70	83	75	71	81	75	74	78.5	73
6	65	76	69	70	74	73	69	74	67	70	80	70	70	83	72	73	83	75	68	84	72	72	85	77	72.5	86	77	74	83	73	70	78	72.5	71	79.	5 71.5
7	68	79	73	68	76	70	70	76	72.5	69	78	69	71	82	71	74	81.5	72.5	68.5	86.5	74	75	86	75	74	85.5	76	70	82	76	70	74	73	66.5	79	71
8	70	78	72	67.5	69	70	71	78	71.5	67	80	70	70	80	68	69	81.5	75.5	74	86	78	70	84	74	70	88	74	73	83	74	73	76	75	69	73	69
9	70	78	72	70	72	70	67.5	76	69.5	68	79	69	67	83	72	74	84	76	75	87	76	72	87	77	73	86	75	73.5	83	75.5	74	74	75	64	78	67.5
10	69	76	74	70	73	71	68	77	71	69	79	73	71	81	72	74	83	74	76	85	77.5	75	88	77	69	84	76	71	83	72	75	78	75.5	65	77	68
11	70	76	69	69	75	73	70	78	72	71	82	73	71	84	75	74	82.5	76	76	81	75	77	86	78	73	85	77	68	81	74	74	79.5	74	68	76	69
12	61	76	72	70	74	72	70	79	71	71	81	70	76	85	76	77	84	74	74	82	75	77	87.5	75	75	86	76	68	81	72.5	74	79	74	68	75	67
13	68	70.5	68	70	68	64	66	80	72	68	80	71	73	83	73	71	83	72	72.5	84	76	74	85.5	76.5	73	84	75	72	80	76	70	77	72	59	76	73
14	71	76	72	59	70	63	67	79	70	69	79	72	72	83	71	72	83	77	74	86	76	75	86	75.5	73	84	75	70	82	75.5	69	76.5	72.5	73	78	73
15	66	77	68	63	74	67	68	78	71	69	78	72	68	84	76	73	86	75	73	85	75.5	70	86.5	77.5	72.5	83.5	74	68.5	84	73.5	72	78	72	72	79	74
16	65	78	71.5	65	74	68	67	78	68	71	79	71	73	80	75	75	84	76.5	73	85	75.5	71	86.5	76	69.5	83	71	69	81	73	71	77	73	74	79.5	76
17	69	72	67	65	72	64	69	79	72	71	80	73	74	83	76	76.5	84.5	76	74.5	86	77	70	85	75	67	83	71	71	83	73	73	78	72	75	79	76
18	67	73	68	57	71	64	71	77	70	72	80	70	74	83	76	76	86	76	74.5	86	76	69	89	76.5	68	85	76	70	86	74.5	70	80	71	78	76	71
19	67	74	67.5	60	72.5	63	69	79	71	68	80	70	76	85	76	75	85.5	75	75	86	75	72	85	76.5	76	85	76	68	82	73	71	80	73	70	79	67
20	68	75	71.5	63	76	69	68	79	72	67	78	68	74	83	75	75	81	76	74	85	74	72	86.5	77	75	84	75	67.5	83.5	74	68	81	71	65	79	69
21	70.5	76.5	72	60	73	63	70	78	69	70	79	69	73	82	74	76	86	76	72.5	85	74	75	86	78	71	81	72	67	83	74	67	80.5	70.5	66	78	69
22	70	76	71	58	73	68	68	82	70	68	81	71	71	82	72	74	86	76	75	83.5	76	76	84	75	71	84	76	69	81	73	67	80.5	70.5	68	68	66
23	68.5	77	71	67	75	64	70	80	72	67	80	70	70	83	74	73	83	75	69	85	75.5	74	85	77	73	84	77	72	82	75	72	80	70	64	76	74
24	71	77	68	60	72	66	72	82	74	71	84	73	70	82	74	75	84	72	71	80	75	77	85.5	78	68	84	77	70	82	74	72	79.5	71	69	71	67
25	64	77	68	59	76	66	72	82	74	71	82	72	71	85	74	73	85.5	71	69	84	76	74	83	78	72	85	77	70	81	74.5	69	78	69.5	67	74	69
26	64	77	69	66	76.5	72	71	79	71	70	84	68	73	85	75	68	86	76	75	84	77	73	85	76.5	69	84	72.5	70.5	80	76	67	77	69.5	67	78.5	69.5
27	69.5	76	69	65	78	71	69	79	67	71	80	74	71.5	86	73	72	84	76	75	83	76	74	84	76	71	83	72.5	73	82	76	69	79	66	68.5	77	69
28	65	77	68	66	78	68	63	75	63	63	80	70	70	82	74	76	85	74	75.5	85	76	76	84	76	70	84	75	76	83	76	65	79	68	67	73	67
29	66	77.5	69	....	....	....	67	78	70	68	80	72	72	82	75	73	85	76	75	84	76.5	76	86	78.5	68	83	73	75	78	77	66	78	69	67	71	66
30	64	77	66	....	....	....	66	83	72	72	78	69	72	83	74.5	75	85	76.5	78	83	76	78	86	78	68	84	74.5	72	86	78	65	78	65.5	66	71	66.5
31	62	74	66	....	....	....	73	81	74	....	....	....	68	84	73	....	....	....	72.5	82	76.5	77	85	77	....	....	....	73	88	76	....	....	....	66.5	72	66.5
Monthly average.	70.6			68.9			72.4			73.4			75.4			77.4			77.9			78.6			77.1			75.7			73.6			71.6		
Total rainfall....	2.44			7.70			3.40			2.15			2.45			0.98			0.59			0.54			0.47			3.56			2.90			9.52		

Total rainfall for the year 36.70 inches.

Temperature averages for each year: 1889, 74.21°; 1890, 74.05°; 1891, 73.81°; 1892, 74.39°; 1893, 73.86°; 1894, 73.08°; 1895, 74.26°; 1896, 74.03; 1897, 74.15°; 1898, 74.20°; 1899, 74.49°; 1900, 74.47°; 1901, 74.42°; thirteen years, 74.11°.

* Mr. Castle's station is at No. 2 on fig. 2. The hours of observation for 1901 probably relate to the adopted standard legal time, which is that of the meridian of 157° 30′ west: Honolulu is in 157° 50′ west.

TABLE 3.—*Record of rainfall, in inches, at Kapoho station (see fig. 3, No. 27), now Puna plantation, 1892 to 1899.*[2]

Month.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
January	13.45	2.55	22.35	1.34	5.43	5.41	15.64	2.83
February	3.95	10.05	24.79	6.45	6.80	3.36	11.41	7.29
March	5.69	9.63	9.60	3.24	10.29	6.18	24.86	8.77
April	2.52	11.88	4.30	8.21	6.89	3.25	3.26	9.40
May	2.33	7.62	1.11	5.58	5.55	2.76	4.17	8.37
June	5.92	4.04	2.75	4.83	2.57	2.59	4.19	6.45
July	6.10	3.54	3.82	6.11	3.02	4.77	4.99	1.65
August	6.15	2.12	2.45	5.94	5.13	5.31	4.12	5.60
September	5.18	3.09	5.09	9.46	4.58	5.99	6.55	2.90
October	9.50	5.44	6.80	9.62	4.28	7.13	6.11	15.48
November	5.20	18.42	7.28	8.64	4.24	12.41	7.22	2.46
December	5.50	5.64	8.48	12.20	4.01	9.74	4.05	3.19
	71.49	83.92	98.82	83.41	62.89	68.90	96.57	74.39

This table shows that irrigation of the sugar cane is never required, and that the continuous and even application of rainfall produces a steady, continuous growth, most conducive to the production of weight and quality of cane.

MEDICAL CLIMATOLOGY.

The climate of Hawaii from a medical point of view has been very interestingly described by Titus Munson Coan, A. M., M. D., in Cohen's System of Physiologic Therapeutics, Vol. IV, pp. 223–241. He finds it especially beneficial to invalids suffering from overwork or exhaustion, as also to the aged and the very young. We quote the following paragraphs:

Temperature.—The Hawaiian has no word for 'weather.' For warm and cold, wet and dry, fair and rainy, and in general for the visible phenomena of the world he has a full nomenclature; but the generic word, a coinage of more variable climates than his own, he does not need. The Hawaiian climate, in a word, is the only tropical climate that is never oppressively hot. Its equability at comfortable temperatures, and its absolute exemption from tornadoes and cyclones, distinguish it from all other warm climates of which we have record, not only from continental climates, like those of California and our Southern States, but also from those of other islands; as from Jamaica and the Bermudas, with their great range of temperatures, from Samoa and Tahiti, with their excessive heat and liability to cyclones, and from the Sundas and the Philippines, with their terrible typhoons, where for half the year the mercury never goes as low as 80° F.

Winds.—The prevailing winds are the northeast trades, at a temperature of about 70° F., and a saturation of about 65 per cent, but these are greatly modified by the mountain masses. Prof. C. J. Lyons, the accomplished observer in charge of the Hawaiian Weather Service, classifies the Hawaiian winds under five heads, as follows:

1. Trade winds of the weather side exposure, the districts of Hamakua and North Hilo on Hawaii, Wailuku on Maui, and Koolau on Oahu. In these districts there is considerable rainfall and a brilliant vegetation.

2. The leeside trade winds, as in Honolulu. The moisture is largely precipitated upon the mountains, but these are not high enough, from 3,000 to 4,000 feet, to keep the wind from sweeping over the ridges and

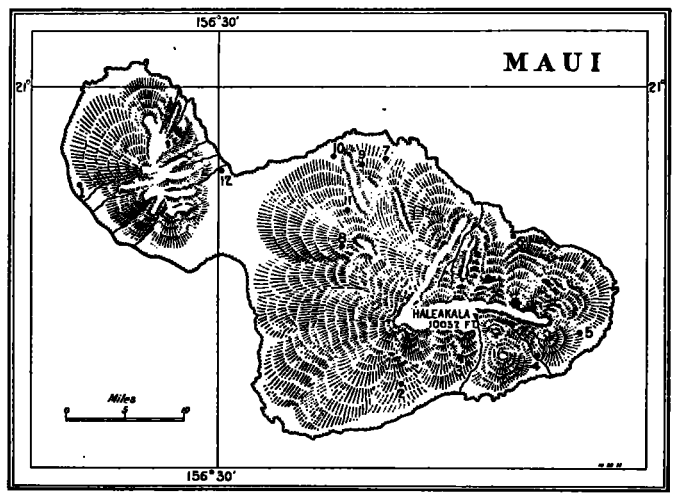

FIG. 4.

No.	Station.	Elevation, feet.	No.	Station.	Elevation, feet.
1.	Lahaina	....	7.	Haiku	700
2.	Waiopae	700	8.	Kula	4,500
3.	Kaupo	285	9.	Puuomalei	1,400
4.	Kipahulu	300	10.	Paia	180
5.	Hamoa	60	11.	Haleakala Ranch	2,000
6.	Nahiku	60, 800, 1,600	12.	Wailuku	200

[2] This record was taken near the sea beach, being the point of least rainfall of any on the plantation. The rainfall on the upper part of the plantation, 5 miles inland, is from 110 to 135 inches a year.

through the deep valleys. By night there is a very gentle land breeze. The trades bring little rain to Honolulu, and the southern slopes of Oahu are arid in comparison with those of the windward side. The winter storms from the southwest, however, make up the needed rainfall.

3. Strong trade wind exposures, at the north and south capes of the islands, as northwest Kohala on Hawaii, Kaupo on Maui, and the south side of Molokai. Here the trades blow uninterruptedly, drearily, endlessly.

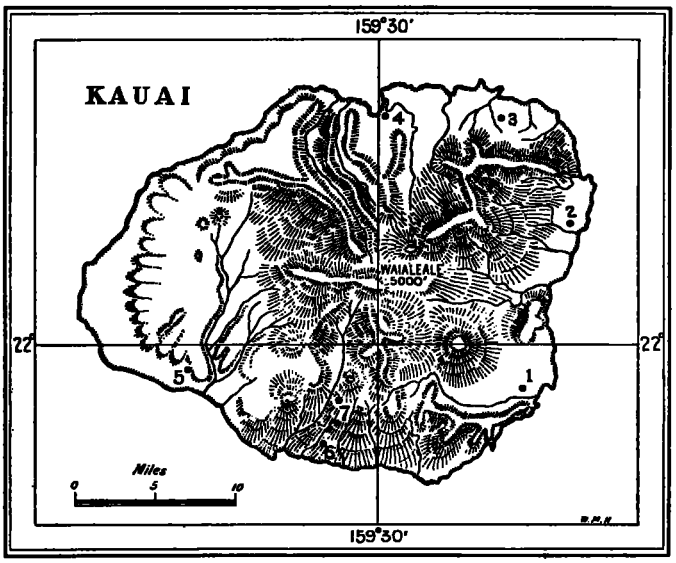

FIG. 5.

No.	Station.	Elevation, feet.	No.	Station.	Elevation, feet.
1.	Lihue	200, 300	5.	Waiawa	32
2.	Kealia	15	6.	Eleele	200
3.	Kilauea Plantation	325	7.	Wahiawa Mountain	2,100
4.	Hanalei	10			

4. The region of alternating land and sea breezes, viz, Hilo Bay and its neighborhood. To the north of Hilo Bay the trade wind divides into two streams, one flowing westward over Hamakua, the other southward, and very gently, often not reaching Hilo Bay until about noon. By night a well-marked land breeze flows down from Mauna Kea, lowering the temperature 10° to 15°. Stormy winds from the north occasionally arise, but in Hilo any strong wind is rare; the southwest gales felt on the other islands are seldom known here. The north wind is the stormy wind; it brings heavy rains. "It is, no doubt, the incessant meeting of the warm vapor from seaward with cool masses of air from the mountains (Mauna Kea) that produces the world-renowned precipitation of Hilo, from 100 to 200 inches per year. An engineer told me he had known a sixteen-inch-deep sugar cooler in the open air to be filled in one night."

5. The leeside land and sea breeze district, viz, the greater part of western Hawaii and of southern Maui. In these regions the sea breeze comes in regularly at about 9 a. m., blowing inland; and as regularly, soon after nightfall, comes the land breeze. From Kawahae to northern Kona, or over the northern part of the coast first mentioned, the "mumuku" also prevails, a violent downrush of trade winds across the northern promontory of the island, abolishing all the local currents for the time being.

The trade winds are regarded by the foreign residents as especially healthful. But a trade wind winter is not a healthy season, being abnormal, and "sickness and mortality, especially among native Hawaiians, are greater than when the regular southerly wind is in due proportion. Much as has been said against the hated south wind, nothing affects the native worse than the north or northwesterly wind." (Lyons.)

The "kona" or southerly gales, usually begin in November—rainy, damp, and blustering winds, at a higher temperature and with higher saturation than those just described. For the foreign residents they are often enervating and depressing, yet the saturation for the months of their prevalence is not materially higher than at other times. The first heavy snows on Mauna Kea and Mauna Loa came in early November, and occasionally cover a full half of the height of the mountain, extending as far downward as to the 7,000-foot level; the huge isolated dome of snow, rising in unobstructed splendor far above the tropic forests, is a spectacle of great sublimity. The top of Mauna Kea is almost exactly on the line of perpetual snow. The entire disappearance of the névé from the summits, as seen from below, is rare; and it is probable that the snow never entirely melts away. I have been on the summit of the mountain in July, and have seen large masses of frozen snow lying in the channels and wrinkles of the terminal cones, in spots where it could not be visible from the coast. But the question of its permanence could be settled only by establishing an observatory on the dome of the mountain; this could be built and maintained at no very great expense, and it would yield data of the highest value, especially in regard to the upper wind currents.

The cumulus clouds are the trade wind clouds; their lower limit in ordinary weather may be 2,800 feet; their upper limit, 8,000 feet. Above this air stream a ceaseless current flows from the northwest, bearing the cirrus clouds, in secular and uninterrupted march, at a height of from 10,000 to 25,000 feet. "During the eruptions of Mauna Loa the column of mineral smoke rises perpendicularly perhaps to 10,000 feet and then rolls away to the northeast" (Lyons).

Rainfall.—It will thus be seen that as to rainfall the islands have a great variety of climates. While some regions are almost rainless, others are deluged; and still others, like Honolulu, the chief place of resort, have a moderate rainfall only—the showers of an English April with the temperature of an Italian June.

* * * * * * *

The rapid discharge of the rainfall on the eastern coast of Hawaii is a sight to behold. I have stood upon the bank of a deep canon in the Hilo district, while the heavy rain-pour was deluging the slopes of Mauna Kea. Far below, a pure mountain stream, easily fordable by leaping from one lava rock to another, was foaming seaward. Presently the noise of unloosed waters came from the mountain side, growing momentarily louder, and soon the torrent, yellow and turbid, came thundering down the rocky valley, with no less force and fury than if a great dam had broken in the mountains; suddenly the little stream was magnified into a roaring and impassable torrent, a hundred times the volume of a few moments before. For days afterwards, and for miles around, the sea would be discolored by the turbid discharge, and the floating driftwood came ashore at distant points along the coast.

The accompanying maps of the individual islands, figs. 2 to 5 inclusive, show the location of the places mentioned in this article they also give the location and elevation of most of the stations for which data are published in the rainfall table furnished monthly by Mr. Lyons. A study of these tables in connection with the maps will prove most interesting. Mr. Lyons promises us a detailed study of the rainfall of the Honolulu district in the near future.—*H. H. K.*

ALASKAN METEOROLOGICAL DATA.

The following interesting climatological data regarding St. Michaels Bay were obtained from the records of the Alaskan Commercial Company by Dr. James T. White of the United States Revenue-Cutter Service.

Statement showing dates of final freezing and departure of the ice in St. Michaels Bay, of the coldest day, and of the first arrival of steamers from the Yukon and from outside in each year from 1874 to 1900.

Year.	Bay closed.	Coldest day.	Bay opened.	First arrival from sea.	First from Yukon River.
1874	Dec. 3	Jan. 1, —28°	.....	.....	.....
1875	Nov. 20	Feb. 15, —28	May 25	.....	.....
1876	Nov. 6	Feb. 19, —46	June 8	.....	.....
1877	Nov. 15	Feb. 7, —41	June 13	June 19	June 22
1878	Nov. 15	Feb. 17, —22	June 15	June 25	Sept. 21
1879	Nov. 9	Jan. 4, —36	June 9	June 22	Sept. 5
1880	Dec. 6	Dec. 17, —43	June 27	June 20	.....
1881	Dec. 7	Feb. 12, —35	June 11	June 14	June 19
1882	Nov. 25	Dec. 10, —24	June 9	June 24	June 17
1883	Nov. 21	Jan. 24, —35	June 8	June 22	June 10
1884	Oct. 10	Feb. 21, —43	June 10	June 7	June 17
1885	Nov. 5	Dec. 29, —33	June 30	June 24	Aug. 27
1886	Nov. 13	Jan. 20, —32	June 5	June 20	June 24
1887	Nov. 2	Jan. 30, —40	June 14	June 20	June 15
1888	Nov. 18	Nov. 28, —20	June 8	June 25	June 8
1889	Nov. 16	Mar. 8, —29	June 23	July 4	June 13
1890	Nov. 11	Jan. 26, —40	June 5	July 13	June 6
1891	Nov. 14	Jan. 30, —30	June 9	June 29	June 7
1892	Nov. 7	Jan. 21, —26	June 11	June 18	June 7
1893	Nov. 5	Feb. 4, —38	June 10	June 21	June 14
1894	Nov. 1	Jan. 14, —36	June 23	June 25	June 18
1895	Dec. 7	Feb. 15, —48	June 18	June 29	June 19
1896	Nov. 21	Mar. 23, —40	June 25	July 7	June 27
1897	Oct. 25	Feb. 19, —31	June 22	July 26	June 22
1898	Oct. 31	Mar. 1, —37	June 13	June 18	June 23
1899	Nov. 7	Jan. 21, —35	June 10	July 17	June 16
1900	Nov. 22	.....	June 8	June 12	June 9
1901	Nov. 2	Jan. 13, Jan. 29, —32	July 3	.....	.....

Dr. White has also forwarded a copy of the meteorological observations made at St. Michaels under his direction, and other information of interest from July 1, 1900, to June 30, 1902, inclusive, and they will be published from time to time in the MONTHLY WEATHER REVIEW.—*H. H. K.*